UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/522,572	01/28/2005	Kun-Hong Lee	LEEK3013/REF	8793

23364 7590 10/10/2007
BACON & THOMAS, PLLC
625 SLATERS LANE
FOURTH FLOOR
ALEXANDRIA, VA 22314

EXAMINER	
QUARTERMAN, KEVIN J	

ART UNIT	PAPER NUMBER
2879	

MAIL DATE	DELIVERY MODE
10/10/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	**Application No.** 10/522,572	**Applicant(s)** LEE ET AL.	
	Examiner Kevin Quarterman	**Art Unit** 2879	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *28 January 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-39* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-39* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *28 January 2005* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *0105; 0907*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Drawings

1. Figure 1 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

2. Claims 1, 3, 4, 6, 11, 22, 26, and 36 are objected to because of the following informalities: Regarding claim 1, the term "an" preceding the term "cathode" in the 6th line of the claim should be replaced with the term "a" instead. Regarding claim 3, it appears that the term "of" should be inserted between the terms "consisting" and "a" in the second line of the claim. Regarding claim 4, a period (.) should replace the semi-colon (;) at the end of the claim. Regarding claim 6, the term "an" preceding the term "cathode" in the 6th line of the claim should be replaced with the term "a" instead. Regarding claim 11, the term "an" preceding the term "cathode" in the 5th-6th line of the claim should be replaced with the term "a" instead. Regarding claim 22, the term "plazma" appears to be misspelled. Regarding claim 26, the term "an" preceding the term "cathode" in the 5th-6th line of the claim should be replaced with the term "a"

instead. Regarding claim 36, the term "plazma" appears to be misspelled. Appropriate correction is required.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1-39 are rejected under 35 U.S.C. 102(b) as being anticipated by Cho (KR 10-2002-0041665).

5. Regarding independent claim 1, the figures of Cho show an electric field emission device having a triode structure fabricated using an anodic oxidation process comprising a supporting substrate (10); a bottom electrode layer (11) formed on the supporting substrate, which is used as a cathode electrode of the device; a gate insulating layer (12) formed on the bottom electrode layer, the gate insulating layer having a plurality of first sub-micro holes (25) to be used as gate holes of the device; a gate electrode layer (13) formed on the gate insulating layer, the gate electrode layer having a plurality of second sub-micro holes each connecting to a corresponding one of the first sub-micro holes; an alumina layer (15) formed on the gate electrode layer, the alumina layer having a plurality of third sub-micro holes each connecting to a corresponding one of the second sub-micro holes; a top electrode layer (Fig. 8) for hermetically sealing the device in a vacuum, which is formed on the alumina layer and used as an anode of the device; and a plurality of emitters (23) for emitting electrons in

a high electric field, each of the emitters being formed in a corresponding one of the first sub-micro holes.

6. Regarding claim 2, Cho discloses the emitter containing metal, semiconductor, or carbon material.

7. Regarding claim 3, Cho discloses the carbon material being selected from a group consisting of a carbon nano-fiber, a carbon nano-tube, a carbon nano-particle, and amorphous carbon material.

8. Regarding claim 4, Figure 7 of Cho shows a resistive layer (19) formed between the bottom electrode and the gate insulating layer.

9. Regarding claim 5, Cho discloses the resistive layer containing SiO_2 or metallic oxide.

10. Regarding independent claim 6, the figures of Cho show an electric field emission device having a triode structure fabricated using an anodic oxidation process comprising a supporting substrate (10); a bottom electrode layer (11) formed on the supporting substrate, which is used as a cathode electrode of the device; a gate insulating layer (12) formed on the bottom electrode layer, the gate insulating layer having a plurality of first sub-micro holes (25) to be used as gate holes of the device; a gate electrode layer (13) formed on the gate insulating layer, the gate electrode layer having a plurality of second sub-micro holes each connecting to a corresponding one of the first sub-micro holes; an anode insulating layer (15) formed on the gate electrode layer, having a plurality of third sub-micro holes each connecting to a corresponding one of the second sub-micro holes; a top electrode layer (Fig. 8) for hermetically sealing the

device in a vacuum, which is formed on the anode insulating layer and used as an anode of the device; and a plurality of emitters (23) for emitting electrons in a high electric field, each of the emitters being formed in a corresponding one of the first sub-micro holes.

11. Regarding claim 7, Cho discloses the emitter containing metal, semiconductor, or carbon material.

12. Regarding claim 8, Cho discloses the carbon material being selected from a group consisting of a carbon nano-fiber, a carbon nano-tube, a carbon nano-particle, and amorphous carbon material.

13. Regarding claim 9, Figure 7 of Cho shows a resistive layer (19) formed between the bottom electrode and the gate insulating layer.

14. Regarding claim 10, Cho discloses the resistive layer containing SiO_2 or metallic oxide.

15. Regarding independent claim 11, Figures 1-8 of Cho show a method for fabricating an electric field emission device having a triode structure by using an anodic oxidation process comprising the steps of forming a bottom electrode (11) on a supporting substrate (10), the bottom electrode layer being used as a cathode electrode of the device; forming sequentially a gate insulating layer (12), a gate electrode layer (13), and an aluminum layer (15) on the bottom electrode layer; forming a plurality of first sub-micro holes in an alumina layer by performing an anodic oxidation process on the aluminum layer, thereby transforming the aluminum layer into the alumina layer; etching a barrier layer of the alumina layer and the gate electrode layer, thereby a

surface of the gate insulating layer being exposed through the first sub-micro holes; forming a plurality of second sub-micro holes in the gate insulating layer, thereby each of the first sub-micro holes connecting to a corresponding one of the second sub-micro holes; forming an emitter (23) for emitting electrons in a high electric field in each of the second sub-micro holes; and forming a top electrode layer (Fig. 8) for hermetically sealing the device on the alumina layer in a vacuum, the top electrode layer being used as an anode of the device.

16. Regarding claim 12, Cho discloses the anodic oxidation process being performed by using an electrolyte selected from a group consisting of oxalic acid, sulfuric acid, phosphoric acid, and chromic acid.

17. Regarding claim 13, Cho discloses the barrier layer of the alumina layer and the gate electrode layer being etched by using one of ion milling, dry etching, and wet etching techniques.

18. Regarding claim 14, Cho discloses the gate insulating layer being etched by using one of ion milling, dry etching, wet etching, and anodic oxidation techniques.

19. Regarding claim 15, Cho discloses each of the emitters being formed by growing metal from a bottom of each of the second sub-micro holes.

20. Regarding claim 16, Cho discloses the metal being grown by applying DC or AC voltage or voltage pulse to a solution of metal sulfate, metal nitrate, or metal chloride.

21. Regarding claim 17, Cho discloses the metal being grown by using a solution of metal sulfate, metal nitrate, or metal chloride after chemically activating a surface of the bottom.

22. Regarding claim 18, Cho discloses each of the emitters being formed by attaching a metal to a bottom of each of the second sub-micro holes.

23. Regarding claim 19, Cho discloses each of the emitters being formed by forming a carbon nano-structure on a bottom of each of the second sub-micro holes.

24. Regarding claim 20, Cho discloses the carbon nano-structure being one of carbon nano-tube, carbon nano-fiber, amorphous carbon, and carbon nano-particle, which are composed by using a thermal decomposition.

25. Regarding claim 21, Cho discloses the thermal decomposition being performed by thermally decomposing a gas mixture of hydrocarbon, carbon monoxide, and hydrogen at 200-800°C.

26. Regarding claim 22, Cho discloses the carbon nano-structure being one of carbon nano-tube, carbon nano-fiber, amorphous carbon, and carbon nano-particle, which are composed by using a plasma decomposition.

27. Regarding claim 23, Cho discloses each of the emitters being formed by thiolizing a pre-synthesized carbon nano-tube and applying thereto an Au-S chemical composition process.

28. Regarding claim 24, Cho discloses each of the emitters being formed by performing an electrodephoresis process on a pre-synthesized carbon nano-structure.

29. Regarding claim 25, Figure 1 of Cho shows more than one emitter formed in each of the second sub-micro holes.

30. Regarding independent claim 26, Figures 1-8 of Cho show a method for fabricating an electric field emission device having a triode structure by using an anodic

oxidation process comprising the steps of forming a bottom electrode (11) on a supporting substrate (10), the bottom electrode layer being used as a cathode electrode of the device; forming sequentially a gate insulating layer (12), a gate electrode layer (13), and an anode insulating layer (15) and an aluminum layer (19) on the bottom electrode layer; forming a plurality of first sub-micro holes in an alumina layer by performing an anodic oxidation process on the aluminum layer, thereby transforming the aluminum layer into the alumina layer; etching a barrier layer of the alumina layer, the anode insulating layer and the gate electrode layer, thereby a surface of the gate insulating layer being exposed through the first sub-micro holes; forming a plurality of second sub-micro holes in the gate insulating layer, thereby each of the first sub-micro holes connecting to a corresponding one of the second sub-micro holes; removing the alumina layer; forming an emitter (23) for emitting electrons in a high electric field in each of the second sub-micro holes; and forming a top electrode layer (Fig. 8) for hermetically sealing the device on the alumina layer in a vacuum, the top electrode layer being used as an anode of the device.

31. Regarding claim 27, Cho discloses the anodic oxidation process being performed by using an electrolyte selected from a group consisting of oxalic acid, sulfuric acid, phosphoric acid, and chromic acid.

32. Regarding claim 28, Cho discloses the alumina layer being removed by dipping the alumina layer in a solution of phosphoric acid or a mixed solution of phosphoric acid and chromic acid.

33. Regarding claim 29, Cho discloses each of the emitters being formed by growing metal from a bottom of each of the second sub-micro holes.

34. Regarding claim 30, Cho discloses the metal being grown by applying DC or AC voltage or voltage pulse to a solution of metal sulfate, metal nitrate, or metal chloride.

35. Regarding claim 31, Cho discloses the metal being grown by using a solution of metal sulfate, metal nitrate, or metal chloride after chemically activating a surface of the bottom.

36. Regarding claim 32, Cho discloses each of the emitters being formed by attaching a metal to a bottom of each of the second sub-micro holes.

37. Regarding claim 33, Cho discloses each of the emitters being formed by forming a carbon nano-structure on a bottom of each of the second sub-micro holes.

38. Regarding claim 34, Cho discloses the carbon nano-structure being one of carbon nano-tube, carbon nano-fiber, amorphous carbon, and carbon nano-particle, which are composed by using a thermal decomposition.

39. Regarding claim 35, Cho discloses the thermal decomposition being performed by thermally decomposing a gas mixture of hydrocarbon, carbon monoxide, and hydrogen at 200-800°C.

40. Regarding claim 36, Cho discloses the carbon nano-structure being one of carbon nano-tube, carbon nano-fiber, amorphous carbon, and carbon nano-particle, which are composed by using a plasma decomposition.

41. Regarding claim 37, Cho discloses each of the emitters being formed by thiolizing a pre-synthesized carbon nano-tube and applying thereto an Au-S chemical composition process.

42. Regarding claim 38, Cho discloses each of the emitters being formed by performing an electrodephoresis process on a pre-synthesized carbon nano-structure.

43. Regarding claim 39, Figure 1 of Cho shows more than one emitter formed in each of the second sub-micro holes.

Conclusion

44. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Takai (US 2003/0090190) discloses a field emission devices using modified carbon nanotubes. Fran (US 6,774,548) discloses a carbon nanotube field emission display. Filas (US 6,741,019) discloses an article comprising aligned nanowires. Choi (US 6,538,367) discloses a field-emitting device comprising field-concentrating nanoconductor assembly. Han (US 6,515,415) discloses a triode carbon nanotube field emission display.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin Quarterman whose telephone number is (571) 272-2461. The examiner can normally be reached on M-TH (7-5:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nimesh Patel can be reached on (571) 272-2457. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Kevin Quarterman
Examiner
Art Unit 2879

kq
30 September 2007

JOSEPH WILLIAMS
PRIMARY EXAMINER